FELT FOR FORMING FIBER CEMENT ARTICLES WITH MULTIPLEX BASE FABRIC

Field of the Invention

The present invention relates generally to fabrics, and more particularly to fabrics employed to form articles of fiber cement.

Background of the Invention

Fiber cement is a well-known material employed in many building components, such as siding, roofing and interior structures, as well as pipes, particularly for waste water transport. Fiber cement typically comprises a mixture of cement (i.e., lime, silica and alumina), clay, a thickener, inorganic fillers such as calcium carbonate, and one or more fibrous materials. In the past, asbestos was commonly included as the fibrous material (*see* U.S. Patent No. 4,216,043 to Gazzard et al.); because of the well-documented problems asbestos presents, now fiber cement typically includes a natural or synthetic fiber, such as acrylic, aramid, polyvinyl alcohol, polypropylene, cellulose or cotton. Fiber cement is popular for the aforementioned applications because of its combination of strength, rigidity, impact resistance, hydrolytic stability, and low thermal expansion/contraction coefficient.

To be used in siding or roofing components, fiber cement is often formed in sheets or tubes that can be used "as is" or later cut or otherwise fashioned into a desired shape. One technique of forming fiber cement articles (known as the Hatschek process) involves creating an aqueous fiber cement slurry of the components described above, depositing the slurry as a thin sheet or web on a porous fabric belt, and conveying the slurry over and through a series of rollers to flatten and shape the slurry. As the slurry is conveyed, moisture contained therein drains through openings in the fabric. Moisture removal is typically augmented by the application of vacuum to the slurry through the fabric (usually via a suction box located beneath the porous fabric). After passing through a set of press rolls, the fiber cement web

can be dried and cut into individual sheets, collected on a collection cylinder for subsequent unrolling and cutting into individual sheets, or collected as a series of overlying layers on a collecting cylinder that ultimately forms a fiber cement tube.

The porous fabric used to support the slurry as moisture is removed is typically woven from very coarse (between about 2500 and 3000 dtex) polyamide yarns. Most commonly, the yarns are woven in a "plain weave" pattern, although other patterns, such as twills and satins, have also been used. Once they are woven, the yarns are covered on the "sheet side" of the fabric (i.e., the side of the fabric that contacts the fiber cement slurry) with a batt layer; on some occasions, the "machine side" of the fabric (i.e., the side of the fabric that does not contact the slurry directly) is also covered with a batt layer. The batt layer assists in the retrieval, or "pick-up," of the slurry from a vat or other container for processing. Because of the presence of the batt layer(s), the fabric is typically referred to as a fiber cement "felt."

Coarse yarns have typically been employed in fiber cement felts because of the severe conditions the felt experiences during processing. For example, fiber cement felts are typically exposed to high load conditions by the forming machine. Also, there can be significant variations in tension over the felt length on the fiber cement machine, as tension may vary from as low as 2 kilopounds/cm after the forming roll to as high as 15 kilopounds/cm over suction boxes. As a result, coarse yarns having high "tenacity" and resilience have been employed. However, because the yarns are coarse, such felts have a tendency to mark the surface of the fiber cement product formed thereon, sometimes to a sufficient degree that smoothing of the surface in a subsequent operation may be required. Further, fiber cement felts are prone to "blinding" (the filling of the openings in the fabric mesh with fiber cement slurry) and typically must be cleaned frequently and may be removed (depending on machine conditions such as speed and load) after as little as one week. Also, such felts tend to suffer significant "compaction" (the tendency of the felt to decrease in thickness) with use. Compaction is detrimental to operation in that, as the felt decreases in thickness, the pressure exerted on the fiber cement by the pressing rolls can decrease, thereby altering the surface characteristics as well as overall physical properties of the sheet. Also, some compaction may be localized, with the result that the fiber cement can have areas of different thickness. Accordingly, once felts have become compacted, they are typically replaced.

One proposed solution to some of these issues is set forth in U.S. Patent No. 5,891,516 to Gstrein et al. The felt disclosed therein is a laminated design, in which separate

woven fabric layers are stacked upon each other and interconnected through the needling of a batt layer. The Gstrein felt has fine machine direction (MD) and cross machine direction (CMD) yarns in the top fabric layer and coarse MD and CMD direction yarns in the bottom layer. Although this felt is successful in some applications, it can suffer in start-up performance because of the additional void volume that is typically created in laminated felt designs.

Summary of the Invention

The present invention is directed to fiber cement felts and methods of forming fiber cement that can improve the fiber cement product produced therewith. As a first aspect, embodiments of the present invention are directed to a fiber cement felt comprising a fabric and a batt layer. The fabric includes: a set of fine top machine direction yarns; a set of coarse bottom machine direction yarns; and a set of fine cross machine direction yarns interwoven with the top and bottom machine direction yarns in a plurality of repeat units. The batt layer overlies and is attached to the set of top machine direction yarns of the fabric. The fineness of the yarns of the top machine direction yarns and the cross machine direction yarns can improve the surface achieved with other fiber cement felts, and can address some of the shortcomings of laminated felts.

In some embodiments, the base fabric is a duplex fabric; in other embodiments, the base fabric is a triplex fabric. The number of top machine direction yarns to bottom machine direction yarns can vary, with ratios of 2:1 to 5:1 being preferred.

As a second aspect, embodiments of the present invention are directed to methods of forming fiber cement. The method comprises the steps of: providing a fiber cement felt of the construction described above; depositing a fiber cement slurry on the fiber cement felt; and removing moisture from the slurry. This method can produce an improved fiber cement product.

Brief Description of the Figures

Figure 1 is a schematic illustration of a fiber cement forming apparatus of the present invention.

Figure 2 is a top view of the top MD and CMD yarns of a repeat unit of a duplex fabric of a fiber cement felt according to embodiments of the present invention, wherein the

top batt layer has been removed.

Figure 3 is a top view of the bottom MD yarns of the repeat unit of the felt of **Figure 2** as they interweave with the CMD yarns, the top MD yarns having been removed for clarity.

Figures 4A-4H are sequential section views of the felt of **Figure 2** taken along lines **4A-4A** through **4H-4H** in **Figure 2**.

Figure 5 is a section view of an exemplary CMD yarn of an alterative duplex fabric for a fiber cement felt according to embodiments of the present invention.

Figure 6 is a section view of an exemplary CMD yarn of another alterative duplex fabric for a fiber cement felt according to embodiments of the present invention.

Figure 7 is a section view of an exemplary CMD yarn of an additional alterative duplex fabric for a fiber cement felt according to embodiments of the present invention.

Figure 8 is a top view of the top MD and CMD yarns of a repeat unit of a triplex fabric of a fiber cement felt according to embodiments of the present invention, wherein the top batt layer has been removed.

Figure 9 is a top view of the bottom MD yarns of the repeat unit of the felt of **Figure 8** as they interweave with the CMD yarns, the top MD yarns having been removed for clarity.

Figures 10A-10H are sequential section views of the felt of **Figure 8** taken along lines **10A-10A** through **10H-10H** in **Figure 8**.

Figure 11 is a section view of an exemplary CMD yarn of an alterative triplex fabric of a fiber cement felt according to embodiments of the present invention.

Figure 12 is a section view of an exemplary CMD yarn of another alterative triplex fabric of a fiber cement felt according to embodiments of the present invention.

Figure 13 is a section view of an exemplary CMD yarn of an additional alterative triplex fabric of a fiber cement felt according to embodiments of the present invention.

Detailed Description of Embodiments of the Invention

The present invention will now be described more fully hereinafter, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, like numbers refer to like elements throughout. Thicknesses and dimensions of some components may be exaggerated for clarity.

Referring now to **Figure 1**, a fiber cement forming apparatus, designated broadly at **10**, is illustrated therein. The forming apparatus **10**, which performs a typical Hatschek process, generally includes an endless fiber cement felt **30** positioned in rolling contact with and driven by a number of guide rolls **20**. Beginning in the lower right corner of **Figure 1**, the felt **30** passes above three vats **12**, each of which contains a batch of fiber cement slurry **14**. As used herein, "fiber cement" means any cementitious composition including cement, silica, and fiber for reinforcement, including asbestos, polyvinyl alcohol, polypropylene, cotton, wood or other cellulosic material, acrylic, and aramid. It is contemplated that other materials such as thickeners, clays, pigments, and the like, that impart desirable processing or performance characteristics to the fiber cement slurry **14** or an article formed therefrom may also be included. Each vat **12** is positioned below a deposition cylinder **16** mated with a couch roll **18**. Each vat **12** also includes an agitator **13** that prevents the fiber cement slurry **14** from solidifying therein.

Rotation of each deposition cylinder **16** collects fiber cement slurry **14** on the cylinder's surface; as the felt **30** travels over and contacts the cylinder **16**, the slurry **14** is transferred from the cylinder **16** to the felt **30**. The amount of slurry **14** deposited on the fabric **30** by each cylinder **16** is controlled by the corresponding couch roll **18**. Preferably, the fiber cement slurry **14** is deposited as a web **21** at a thickness of between about 0.3 mm and 3 mm.

Still referring to **Figure 1**, once the fiber cement slurry web **21** has been collected on the felt **30** from each of the vats **12**, the felt **30** conveys the slurry web **21** over one guide roll **20**, then over one or more suction boxes **26** (two are shown in **Figure 1**), each of which applies negative pressure to the felt **30**, thereby encouraging the removal of moisture from the slurry web **21**. Finally, the felt **30** and the slurry web **21** pass over a second guide roll **20**, then between the nip formed by a breast roll **24** and a forming roll **22**. After passing through the nip, the slurry web **21** has formed into a semi-solid fiber cement sheet **28** that is collected on the surface of the forming roll **22**.

Those skilled in this art will recognize that other forming apparatus are also suitable for use with the fiber cement felts of the present invention. For example, felts of the present invention can also be used to form fiber cement pipe. In such an operation, the fiber cement sheet **28** can be collected in contacting layers on a forming roll; as they dry, the overlying layers form a unitary laminated tube. Often, a pipe forming apparatus will include small couch rolls that act in concert with the forming roll to improve interlaminar strength. Also, a

second felt may travel over the additional couch rolls to assist in water absorption and finishing.

The configuration of the felt **30** can be best understood by reference to **Figures 2-4H**. The felt **30** has a duplex base fabric **31** having a repeat unit that includes a set of thirty-two fine top MD yarns **32** and a set of eight coarse bottom MD yarns **34**. These are interwoven with a set of eight CMD yarns **36**. To clarify, as used herein the term "machine direction" refers to the direction the felt **30** travels on the fiber cement apparatus **10**, and the term "cross machine direction" refers to the direction perpendicular to the machine direction and parallel to the plane defined by the felt **30**. Within the felt **30**, the terms "top", "upper" and derivatives thereof refer to the portion of the felt **30** that faces the fiber cement stock (*i.e.*, toward the sheet side of the felt **30**), and the terms "bottom", "lower" and derivatives thereof refer to the portion of the felt **30** that faces the machine components of the fiber cement forming apparatus **10** (*i.e.*, toward the machine side of the felt **30**). The term "duplex" refers to a fabric that has two sets of MD yarns at different elevations within the fabric **31** interwoven with a single set of CMD yarns.

As can be seen in **Figures 2-4H**, each CMD yarn **36** follows a similar weave pattern relative to the top MD yarns **32**. Referring to **Figure 4G**, the CMD yarn **36g** illustrated therein passes above two top MD yarns **32a, 32b**, below the next two top MD yarns **32c, 32d**, above the next two top MD yarns **32e, 32f**, below the next two top MD yarns **32g, 32h**, above the next two top MD yarns **32i, 32j**, below the next two top MD yarns **32k, 32l**, above the next two top MD yarns **32m, 32n**, and below the remaining eighteen top MD yarns **32**. As the CMD yarn **36g** passes below eighteen top MD yarns, it also passes above a bottom MD yarn **34d**, stitches below the next bottom MD yarn **34e**, passes above the next bottom yarn **34f**, stitches below the next bottom MD yarn **34g**, and passes above the next remaining bottom MD yarn **34h** before returning to the top layer of the fabric to interweave with the top MD yarns **32** (and, in doing so, passing above three bottom MD yarns **34**).

Each CMD yarn **36** is woven adjacent another CMD yarn **36** that interweaves with top MD yarns **32** in a complementary manner such that, together, the adjacent CMD yarns complete an entire weaving sequence with the top MD yarns. As an example, CMD yarn **36h**, which is illustrated in **Figure 4H**, is passing below top MD yarns **32** and stitching with bottom MD yarns **34** when its adjacent CMD yarn **36g** is interweaving with the top MD yarns **32** in the "over two/under two" pattern described above. Conversely, when the CMD yarn **36g** is passing below eighteen consecutive top CDM yarns as described above (*i.e.*, when it is

stitching with bottom CMD yarns **34**), the CMD yarn **36h** is interweaving in the same type of "over two/under two" pattern with the top CMD yarns **32**. As a result, together the CMD yarns **36g, 36h** form an unbroken "over two/under two" pattern for the entirety of the repeat unit of the fabric **31**, and stitch below every other bottom MD yarn **34**.

Each of the other CMD yarns **36** has an adjacent CMD yarn with which it pairs to form the desired "over two/under two" pattern" (*i.e.*, CMD yarns **36a, 36b** form an adjacent pair, as do CMD yarns **36c, 36d** and **36e, 36f**). Adjacent pairs of CMD yarns **36** are offset from one another to enable two CMD yarns **36** to pass over every top MD yarn **32** at some location in the repeat unit, and to do so by passing over that top MD yarn **32** as well as passing over each of its neighboring top MD yarns **32** once (for example, and as shown in **Figures 4F** and **4G**, the leftmost top MD yarn **32a** is passed over by CMD yarn **36g** in conjunction with the second leftmost top MD yarn **32b**, and is also passed over by CMD yarn **36f** in conjunction with the rightmost top MD yarn **32o**). Similarly, the pairs of CMD yarns **36** are offset from each other such that each bottom MD yarn **34** has two knuckles formed underneath it by two different CMD yarns. For example, CMD yarns **36c** and **36h** form knuckles below leftmost bottom MD yarn **34a**.

As noted above, the top MD yarns **32** are fine yarns. Exemplary fine yarns are single monofilaments with a diameter of between about 0.2 and 1.0 mm, twisted monofilaments of the same diameter range, spun yarns, multifilaments, and other twists. The CMD yarns **36** are also fine yarns. Exemplary fine yarns for the CMD yarns **36** include single monofilaments with a diameter of between about 0.3 and 1.0 mm, twisted monofilaments of the same diameter range, spun yarns, multifilaments, core-wrapped yarns, and other twists. The bottom MD yarns **34** are coarse yarns. Exemplary coarse yarns for the bottom MD yarns **36** include twists from about 300 to about 4,500 dtex, typically formed of spun yarns, cross-linked yarns, multifilaments, core-wrapped yarns and twists thereof. As used herein, the term "tex" refers to the well-known unit of fineness used to describe textile yarns, in which the number of tex is equal to the mass in grams of a 1000 meter length of yarn. The term "dtex" refers to one-tenth of a "tex", or the mass in grams of a 100 meter length of yarn.

The materials comprising yarns employed in the fabric of the present invention may be those commonly used in fiber cement felts. For example, the yarns **32, 34, 36** may be formed of cotton, wool, polypropylene, polyester, aramid, polyamide, or the like, with polyamide yarns being preferred for both the top and bottom MD yarns **32, 34** and the CMD

yarns **36**. Of course, the skilled artisan should select yarn materials according to the parameters of the fiber cement forming process.

In one desirable embodiment, the top MD yarns **32** are monofilaments having a diameter of between 0.2 and 1.0 mm, the bottom MD yarns **34** are combination twists of multifilaments and spun yarns of 300-4,500 dtex, and the CMD yarns **36** are monofilaments or twisted monofilaments having a diameter of between about 0.3 and 1.0 mm.

Referring to **Figure 4A**, the felt **30** also includes upper and lower batt layers **50, 52**. The batt layers **50, 52** should be formed of a material, such as a synthetic fiber like acrylic ananeid, polyester, or polyamide, or a natural fiber such as wool, that assists in taking up fiber cement slurry **14** from the vats **12** to form the fiber cement web **21**. Preferred materials include polyamide, polyester and blends thereof. The weight of the batt layers **50, 52** can vary, although it is preferably that the ratio of batt weight to fabric weight is about between about 1.0 and 2.0 with 1.5 being more preferred. Also, in some embodiments, it may be desirable to omit the bottom batt layer **52**. Typically, the batt layers **50, 52** are attached to the fabric **31** via needling, although other processes known to those skilled in this art may be employed.

Other weave patterns may also be employed in duplex base fabrics of the felt **30**. For example, **Figure 5** illustrates a duplex fabric **130** for a felt having a repeat unit that includes sixteen fine top MD yarns **132**, eight coarse bottom MD yarns **134**, and eight fine CMD yarns **136** (only one exemplary CMD yarn **136** is shown herein). The CMD yarns **136** are interwoven with the top MD yarns **132** such that each CMD yarn **136** forms two two-knuckle floats over top MD yarns **132** that are separated by two top MD yarns **132**. Pairs of adjacent CMD yarns together form an unbroken pattern of the "over two/under two" sequence much like that of the embodiment of **Figures 2-4H**. Further, each CMD yarn **136** passes below two bottom MD yarns **134** that are separated by one bottom MD yarn **134**. The other CMD yarns **136** have a similar pattern in interweaving with the top and bottom MD yarns **132, 134**, but are offset from each other such that each top MD yarn **132** passes under two different CMD yarns **136**, and such that each bottom MD yarn **134** passes over two different CMD yarns **136**.

Referring now to **Figure 6**, another embodiment of a duplex fabric (designated broadly at **230**) that can be employed with fiber cement felt embodiments of the present invention is illustrated therein. The fabric **230** has repeat units that include a set of twenty-four fine top MD yarns **232**, a set of eight coarse bottom MD yarns **234**, and a set of eight

fine CMD yarns **236**. The CMD yarns **236** are interwoven with the top MD yarns **232** to form three two-knuckle floats, each of which is separated by two top MD yarns **232**. The CMD yarns **236** are interwoven with the bottom MD yarns **234** such that they form two knuckles below bottom MD yarns **234** that are separated by one bottom MD yarn **234**. The other CMD yarns **236** have a similar pattern in interweaving with the top and bottom MD yarns **232, 234**, but are offset from each other such that each top MD yarn **232** passes under two different CMD yarns **236**, and such that each bottom MD yarn **234** passes over two different CMD yarns **236**.

Figure 7 illustrates another duplex fabric **330** that can be employed with fiber cement felt embodiments of the present invention. The fabric **330** has repeat units that include a set of forty fine top MD yarns **332**, a set of eight coarse bottom MD yarns **334**, and a set of eight fine CMD yarns **336**. The CMD yarns **336** are interwoven with the top MD yarns **332** to form five two-knuckle floats, each of which is separated by two top MD yarns **332**. The CMD yarns **336** are interwoven with the bottom MD yarns **334** such that they form two knuckles below bottom MD yarns **334** that are separated by one bottom MD yarn **334**. The other CMD yarns **336** have a similar pattern in interweaving with the top and bottom MD yarns **332, 334**, but are offset from each other such that each top MD yarn **332** passes under two different CMD yarns **336**, and such that each bottom MD yarn **334** passes over two different CMD yarns **336**.

Referring now to **Figures 8-10H**, a triplex fabric **400** that is suitable for use in embodiments of the felt **30** is illustrated therein. As used herein, the term "triplex" refers to a fabric that includes three sets of MD yarns at different elevations within the fabric interwoven with a set of CMD yarns. The fabric **400** has repeat units that include a set of thirty-two fine upper top MD yarns **432**, a set of thirty-two fine lower top MD yarns **433**, a set of eight coarse bottom MD yarns **434**, and a set of eight fine CMD yarns **436**. As can be seen in **Figures 10A-10H**, the upper MD top yarns **432** are positioned above the lower top MD yarns **433**. The CMD yarns **436** interweave with the upper and lower top MD yarns **432, 433** and the bottom MD yarns **434** to form the fabric **400**.

Each of the CMD yarns **436** follows a similar path in interweaving with the MD yarns. Using as an example CMD yarn **436b** (shown in **Figure 10B**), the CMD yarn **436b** begins below one pair of upper and lower top MD yarns **432a, 433a**, weaves between the next pair of upper and lower top MD yarns **432b, 433b**, passes above the next upper top MD yarn **432c** to form a knuckle thereover, and weaves between the next pair of upper and lower

top MD yarns **432d, 433d**. This sequence is repeated three more times with the next twelve upper and lower MD yarns **432, 433**. The CMD yarn **436b** then passes below the next sixteen pairs of upper and lower top MD yarns **432, 433** as it interweaves with the bottom MD yarns **434**. More specifically, the CMD yarn **436b** stitches below bottom MD yarn **434e**, passes above the next bottom MD yarn **434f**, stitches below the next bottom MD yarn **434g** and passes above the next bottom MD yarn **434h** as it travels upwardly to begin the sequence again by interweaving with the upper and lower top MD yarns **432, 433**.

As can be seen in **Figures 10A-10H**, each of the CMD yarns follows a similar sequence: each CMD yarn interweaves with the upper and lower top MD yarns such that it forms four knuckles over single upper top MD yarns **432** that are separated from each other by three upper top MD yarns, and each CMD yarn **436** stitches below two bottom MD yarns **434** that are separated from each other by one bottom MD yarn **434**. For each CMD yarn **436** there is an adjacent CMD yarn **436** that is woven in a complementary manner, such that together the two CMD yarns **436** of the pair form a continuous "over one/under three" sequence with the upper top MD yarns **432** and a continuous "over one/under one" sequence with the bottom MD yarns **434**. The pairs of CMD yarns **436** are offset from one another such that one knuckle is formed over each upper top MD yarn **432** and two knuckles are formed under each bottom MD yarn **434**.

Other weave patterns may also be employed in the triplex fabrics of the felt **30**. For example, **Figure 11** illustrates a triplex fabric **500** for a felt having a repeat unit that includes sixteen fine upper top MD yarns **532**, sixteen fine lower top MD yarns **533**, eight coarse bottom MD yarns **534**, and eight fine CMD yarns **536** (only one exemplary CMD yarn **536** is shown herein). The CMD yarns **536** are interwoven with the upper and lower top MD yarns **532, 533** such that two knuckles are formed over upper top MD yarns **532** that are separated by three upper top MD yarns **532**. Also, the CMD yarns **536** are interwoven with the bottom MD yarns **534** such that they stitch below two bottom MD yarns **534** that are separated by one bottom MD yarn **534**. The other CMD yarns **536** are offset from one another such that one knuckle is formed over each upper top MD yarn **532** and two knuckles are formed below each bottom MD yarn **534**.

Referring now to **Figure 12**, a triplex fabric **600** having a repeat unit that includes twenty-four upper top MD yarns **632**, twenty-four lower top MD yarns **633**, eight bottom MD yarns **634** and eight CMD yarns **636** is illustrated therein. The CMD yarns **636** are interwoven with the upper and lower top MD yarns **632, 633** such that three knuckles are

formed over upper top MD yarns **632** that are separated by three upper top MD yarns **632**. Also, the CMD yarns **636** are interwoven with the bottom MD yarns **634** such that they stitch below two bottom MD yarns **634** that are separated by one bottom MD yarn **634**. The other CMD yarns **636** are offset from one another such that one knuckle is formed over each upper top MD yarn **632** and two knuckles are formed below each bottom MD yarn **634**.

Figure 13 illustrates another triplex fabric **700** that can be employed with fiber cement felt embodiments of the present invention. The fabric **700** has repeat units that include forty upper top MD yarns **732**, forty lower top MD yarns **733**, eight bottom MD yarns **734** and eight CMD yarns **736** is illustrated therein. The CMD yarns **736** are interwoven with the upper and lower top MD yarns **732, 733** such that five knuckles are formed over upper top MD yarns **732** that are separated by three upper top MD yarns **732**. Also, the CMD yarns **736** are interwoven with the bottom MD yarns **734** such that they stitch below two bottom MD yarns **734** that are separated by one bottom MD yarn **734**. The other CMD yarns **736** are offset from one another such that one knuckle is formed over each upper top MD yarn **732** and two knuckles are formed below each bottom MD yarn **734**.

For all of the base fabrics **130, 230, 330, 400, 500, 600, 700** illustrated in **Figures 5-13**, the discussion above regarding the form and materials of yarns employed therein is equally applicable. Also, although not explicitly illustrated, those skilled in this art will appreciate that each of the fabrics may be attached to one or more batt layers such as the batt layers **50, 52** discussed above. It should also be understood that other weave patterns for the fabrics of the fiber cement felts of the invention may also be employed.

Fiber cement felts having fabrics as discussed above may provide significantly better sheet quality than other prior fabrics, particularly coarse single layer fabrics or double layer fabrics with a coarse upper layer. Also, felts of the present invention may have improved drainage due to more efficient pressure support, and may also have improved compaction resistance.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention. The invention is defined by the following claims, with equivalents of the claims to be included therein.